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A PRELIMINARY REPORT ON RICE INVESTIGATIONS.

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Rice is, next to sugar, one of the important Hawaiian crops. The industry has recently been in a bad way through increasing competition with Japanese and Louisiana rices, and to some extent through deterioration of the local product. A series of experiments has therefore been begun by the Hawaii Experiment Station to determine what improvements in methods of cultivation, harvesting, fertilization, milling, breeding and selection, can be introduced to bring about the rehabilitation of the industry.

These experiments are made possible by the generous contribution of the Bernice Pauahi Bishop Estate and also thro the use of lands placed at the Station's disposal by the Ii Estate, Ltd.

Three projects or lines of work have thus far been planned for these investigations, as follows: Rice culture; rice breeding; and fertilization and rotation.

In these projects the first object is to work out the general principles underlying the problems in hand, if these are as yet unsolved, and to demonstrate how these principles may be ap-

plied to field practice. It then becomes the duty of the farmer to further extend the Station's work, and he will profit most who continues to experiment and develop.

It is estimated that three years will be required for the completion of these investigations. Being more or less closely related, the several projects will be carried on together. Duplications will doubtlessly be necessary to verify early conclusions. Laboratory experiments almost invariably precede the plot tests and these in turn are followed by more extended field trials.

Rice Culture,—including Tillage, Seedage and Harvesting Operations. This project principally involves practical field experiments to devise first, more thorough and cheaper methods of tillage than are now in vogue. The slow, laborious methods of ploughing and harrowing our rice fields is familiar to all. A small eight or ten inch mould-board plow drawn by two to four undersized horses, or two water-buffalo, and attended by two or even three men, ploughing one to one and one-half acres per day, is grotesque in the extreme to an American farmer, yet this method has been in vogue in Hawaii for sixty years.

The Station has planned a series of tillage experiments with modern disc implements, the cut-away type having been selected as best adapted to our conditions. In a recent preliminary trial with a cut-away bog plow, drawn by four medium sized horses, one man ploughed at the rate of 4.6 acres in a day of ten hours. This is three to four times as much as is ploughed by the ordinary method, and with one man less.

The implement used in these trials consists of a gang of eight 24-inch discs cutting five feet, which is half lapped. Theoretically this plow should plow to a maximum depth of eight inches, but four inches was the extreme depth plowed in our trial, not quite sufficient for general purposes, but it is believed some slight modifications will obtain deeper penetration where desirable. It is found that the ground is left in better tilth by the disc than by the mold-board plow, and in every way, this new implement should prove a great labor and time-saver.

Seedage. In planting the rice crop, considerable experimental work offers itself, the slow, tedious transplanting methods would

seem supplementable by machine sowing where areas are of sufficient size. On the other hand, it may prove economical in the long run because of increased yields, to continue to transplant as is now the custom. The question of drainage of large fields must also be considered. However in our acre trial-ground, the crop which was entirely drilled by hand in permanent rows is growing luxuriantly, and this suggests the feasibility of drilling the rice crop by machinery. A somewhat extensive coöperative experiment in rice culture has just been planned wherein five or ten acres are to be sown with a modern force feed drill attached to a disc harrow.

A trial of broadcast sowing in comparison may also be attempted, though the main difficulty to be feared from all direct sowing is foulness from weeds, but it is hoped that cleaner tillage, aided by a system of rotation may overcome this serious hindrance.

Harvesting. The shortcomings of the antiquated oriental method of harvesting the rice crop with the sickle must be apparent to all. Doubtless many have thought of the feasibility of using the modern reaper or self-binding grain harvester in the larger rice fields, yet our trial of the rice harvester and binder on August 18, 1906, was the first attempt to use a modern harvester on a Hawaiian rice crop. The success of this experiment leaves little to be desired. It demonstrated that a large area of well drained rice fields may be modified to permit of the successful operation of this great labor saving machine[1].

Under this project also belongs the study of the duty of water in rice culture. Laboratory cultures, supplemented by experiments at the rice trial-grounds indicate that rice can be successfully grown with much less irrigation water than is now generally used, at least this is true on some types of soil, those of a sandy, gravelly, porous nature. Soils of this character at Mokuleia, Oahu, are under investigation at this time.

Drainage is intimately associated with irrigation. Our investigations have not yet progressed sufficiently to indicate the im-

[1] A fuller description of the trial may be found in the Hawaiian Forester and Agriculturist for November, 1906.

portance of such practice in Hawaiian rice culture. However, it is some satisfaction to note that a suggestion made some years ago, has led to the tendency of our rice-growers to drain their lands more thoroughly at the time of harvest and to do much of their ploughing under half dry conditions where formerly nearly all lands were worked while partially submerged. The beneficial results following thorough aeration are so well understood elsewhere, that the wonder is that such practice is not now generally carried out in Hawaii.

Rice Breeding. Probably no one phase of these rice investigations promises better results than the development and introduction of new rices for culture in Hawaii. The splendid work done in the breeding of new wheats, corn, sugar-beets, cotton, etc., within the last decade, are more or less familiar to all. The same principles underlie and equal results promise in the development of rice, and the major portion of our efforts will continue to be exercised in this direction.

Through the active coöperation of the Office of Experiment Stations, and the Bureau of Plant Industry of the U. S. Department of Agriculture at Washington, D. C., the Station was enabled to secure one hundred and fifty varieties of rice from foreign countries for comparative test with the best existing Hawaiian varieties.

A suitable piece of land has been leased for experimental purposes at the junction of King Street and Kalakaua Avenue, Honolulu. All the varieties were planted side by side under exactly the same conditions. On January 1, 1907, nearly one hundred varieties had been harvested. Critical field-notes have been made throughout the growing season. Milling and culinary tests still remain to be made of all varieties harvested. When the resulting data is tabulated, the relative value of each variety can be determined.

From the data now in hand very encouraging results are promised. Two varieties, Nos. 17144 '06 and I. E. '06, the for-

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mer an Egyptian variety and the latter, one of twelve Filipino rices, have thus far proved themselves superior to our best Ha-

waiian types from the grower's, the miller's and the consumer's standpoints. Should another season's trial verify our present conclusions, an important advance will have been gained in the Hawaiian rice industry through the introduction of these varieties. Other promising varieties will receive further trial and numerous crosses will be attempted by artificial hybridization to incorporate into one variety the good qualities of two or more kinds. As soon as a superior variety is developed, seed will be propagated in sufficient quantity for general distribution. It is expected to produce enough stock of Nos. $\frac{17144}{65}$ and $\frac{\text{I. E.}}{73}$ this coming season to send out small quantities for trial in time for fall planting in 1907.

An important phase of the rice-breeding work now in hand is the improvement and establishment of a pure type of the best existing Hawaiian rices. Careful selections of individual plants were made a year ago and again this year from the best rice areas. The seeds of each of these selected plants were sown separately, and further careful selections made from among their progeny. By a process of continuous selection and elimination, from plants of known parentage a pedigreed seed-stock is being developed which may in time almost double the yields produced from unselected stocks. A single test in our trial-grounds the past season gave the following results:

Rice Sample I. Seed taken directly from general run of paddy as it left the thrasher at Palama rice fields:

200 feet of drill produced.....11 pounds, 4 ozs.

Rice Sample II. Seed taken from one plant selected from among several hundred of an unusually good stand at Palama rice fields:

200 feet of drill produced.....16 pounds, 1 oz.

representing a gain of 45 per cent. as the result from using selected seed alone.

While it is true that the Chinese rice grower does select his seed to some extent and further selects the seedlings from the transplanting beds, he has not yet learned the importance of intensive scientific selection.

A small amount of wet and dry land rice is now available for distribution to parties desiring the same for trial.

Chemical Fertilizers, Rotation of Crops, Rice Diseases and Insect Pests.—This project offers a wide field for investigation, especially in the matter of fertilization and the discovery of substitute crops, either to enter into a rotation or to permanently supplant rice where its profitable culture is impossible.

Fortunately Hawaiian rice is remarkably free from destructive diseases. Dr. N. A. Cobb, in charge of Pathological work in Hawaii for the U. S. Department of Agriculture, has now under investigation several slightly infected specimens collected during the past half year, and while nothing serious has thus far been found, it intensifies the importance of vigilance to exclude from Hawaii the several disastrous diseases known to rice elsewhere.

The only insect pests noted on growing rice is a grass-hopper, *(Xiphidium varipenne,* Swezey.)[1] and to a very slight extent, the short-horned grass-hopper, *(Oxya velox Fabr.).* The former during some seasons is very prevalent in our rice fields, especially along their borders, and along ditches where grass and weeds prevail. The grass-hopper usually attacks the rice while in flower, its peculiar procedure being to gnaw an opening in the flat side of the flowering glume, thence emasculating the flower of its pollen filled anthers, or as is frequently the case, the pest awaits the protrusion of the anthers and devours them one after another as they appear and before the pollen has had time to shed[2]. Less frequently, and as the season advances, the hopper will often be seen eating out the maturing grain from between the harsh, horny hulls. From the smallest nymph to the fully developed adult, every intermediate size of grass-hopper may be seen in fields at the same time, but as the grain matures they decrease in number so that at the time of harvest practically all have disappeared. The injury to the crop from this source

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[1] Identified by D. L. Van Dine, Entomologist, Hawaii Experiment Station.

[2] Upon dissection, Mr. Van Dine has found a large part of the stomach contents to consist of pollen grains,

while considerable, has not as yet become a menace. The Chinese rice growers, while aware of the pest, do not concern themselves about it, not even knowing the nature of the injury done.

Not to lose sight of the other important objects in this general project, the subjects of chemical fertilizers and crop rotation in rice culture, it may be briefly stated that the work along these lines will be directed so as to determine the value of and most economical uses of chemical fertilizers. Hitherto, stable manure has been almost the only fertilizer used, but the supply is inadequate and it is apparently not the best fertilizer to use. The strong, vigorous growth of the rice crop is often commented upon, but the rice millers tell us that the grain itself is deteriorating from year to year, due in part at least, the writer believes, to a one-sided fertilization. The excessive lodging of our rices in wet weather may likewise be traced to this source.

The Station has recently completed a series of pot fertilizer tests, which, supplemented by field plot tests planned for the coming spring crop should shed needed light on this question.

Lastly, the practice of crop rotation in Hawaiian Rice Culture is in its infancy. Except for the reclamation of small unimportant areas which have been planted to bananas and vegetables, no systematic rotation seems to have been thus far undertaken. However, the Station will make this phase of its investigations an important element. It is believed that a valuable crop has been discovered to plant alternately with rice, but it will require several years for its full development.

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Honolulu, Hawaii, January 19, 1907.